REMARKS

Upon entry of the Amendment, Claims 1-3 and 5-8 will be pending in the application.

Claim 1 is amended to recite, "the through-hole being defined by a wall and the internal electrode layer having an end portion spaced apart from the through-hole wall". Support is found, for example, in paragraph [07] at pages 4-5 of the specification.

Claim 1 is further amended to incorporate the recitation of "wherein the filler is an electrically conductive paste containing an organic solvent and metallic powder having an average particle size of 2 μm or less", based on support, for example, in dependent Claim 4, now canceled.

Claims 5-6 are amended to depend from claim 1.

Claim 7 is a new dependent claim directed to forming a through-hole by means of a laser beam which causes the end portion of the internal electrode layer to retract from the wall defining the through-hole. See also paragraph [07] for support.

New Claim 8 depending from Claim 1 is drawn to a method for producing a multi-layer ceramic capacitor.

Applicants also amend the specification to correct a typographical error at page 7, paragraph [13] which now describes an aspect ratio of 4 to [2] 25, to conform with Claim 6.

No new matter is added.

Entry of the Amendment along with reconsideration and review of the claims on the merits are respectfully requested.

Formal Matters

Applicants appreciate the Examiner's acknowledgment of Applicants' claim for foreign priority and confirmation of receipt of the certified copy of the priority document.

Applicants also appreciate that the Examiner has reviewed and considered the references cited in the Information Disclosure Statements filed October 8, 2003, and January 14, 2004.

Claim Rejections - 35 U.S.C. § 103

A. Claims 1-3, 5 and 6 were rejected under 35 U.S.C. §103(a) as being unpatentable over Mosley (US Pat. No. 6,801,422) in view of JP 03-241890 Patent Abstract (JP '890).

The Examiner cites Mosley as disclosing a method of making a capacitor comprising: printing dielectric sheets with tungsten paste; stacking the sheets; forming via holes in the stack by process such as laser drilling; filling the via holes with a metal slurry to form vias to connect conductive layers to connection sites; and co-firing. The capacitor has a thickness of between 0.5 mm and 1 mm, a top surface area of about 1 cm^2 and can have about 4000 connection sites with a pitch of about 100-500 microns between connection sites (col. 3, line 21-63).

The Examiner acknowledges that Mosley does not disclose filling the via holes under application of pressure. However, the Examiner cites JP '890 as teaching that paste can be accurately and densely filled in an easy and efficient filling operation in through-holes in a stack of green sheets by placing the stack of green sheets on a paste tank filled with paste, placing a pressing plate on the stack and pressing the plate and paste in the tank at the same pressure to fill the through-holes, where the paste has a viscosity of at least 50×10^4 cps (500 Pa·s).

B. Claim 4 was rejected under 35 U.S.C. §103(a) as being unpatentable over Mosley in view of JP '890 as applied to Claim 1 above, and further in view of Tani et al. (US Pat. No. 5,985,461).

The Examiner cites Tani et al. as teaching that electroconductive paste for filling via holes in green sheets contain metal powder of grain size in the range of 0.1-50 microns and organic vehicle of binder dissolved in a solvent.

Applicants respond as follows.

A conventional multi-layer electronic component has a problem with its through-holes. Since an internal electrode layer has a melting point lower than that of ceramic sheets sandwiching the internal electrode layer, when the through-hole is formed by laser irradiation, melting of the internal electrode layer, which occurs by means of heat generated through laser irradiation, precedes melting of the ceramic sheets. As a result, a phenomenon may occur in which the surface of an end of the internal electrode layer that faces the thus-formed through-hole retracts from the wall which defines the through-hole. This phenomenon may be called an "electrode receding phenomenon".

In the case where such an electrode receding phenomenon occurs, when an electrically conductive paste is charged (under application of pressure) into the through-hole, although the through-hole is filled with the conductive paste, the conductive paste may fail to reach the "receded" end surface of the internal electrode layer. This is because the internal electrode layer sandwiched between the ceramic sheets has a thickness as small as several μm. When such a phenomenon occurs, the electrically conductive paste charged into the though-hole fails to contact the internal electrode layer, and thus electrical conduction between the conductive paste and the internal electrode layer is not established. Therefore, the resultant electronic component in the prior art may fail to exhibit the performance intended by its design (see pages 2-3, bridging paragraph).

Turning to the cited prior art, neither Mosley nor JP '890 recognized the problem of receding electrodes. Both the cited references do not describe an electrode layer having an end portion spaced apart from the through-hole wall.

To clarify this distinction over the prior art, and particularly, to point out that end surface 24c retracts from the wall defining through-hole 26 in the through-hole forming step, Claim 1 has been amended to recite that "the through-hole being defined by a wall and the internal electrode layer having an end portion spaced apart from the through-hole wall".

Based on at least the above amendment to Claim 1, Applicants submit that it would not have been obvious to fill the via paste of Mosley under pressure and using the paste container of JP '890 in order to provide "an easy and efficient filling operation for accurately and densely filling through-holes in a green sheet stack with paste".

More particularly, considering that neither Mosley nor JP '890 recognized the problem of receding electrodes, it is recognition of the source of the problem (melting of internal electrode layers which proceeds melting of ceramic sheets when through-holes are formed by laser irradiation), and it is Applicants' solution thereof (charging filler into the through-hole under pressure such that the filler reaches the receded end portions), which is accordingly unobvious over the prior art. Furthermore, even if combinable, combining Mosley with JP '890 would still not achieve the present invention. Namely, the filler is not simply charged into the through-hole under any pressure, but rather under such pressure that the filler reaches an end portion of each of the predetermined internal electrode layers.

Moreover, the subject matter of Claim 4 has been incorporated into Claim 1. Tani et al. does not disclose or teach a "metallic powder having an average particle size of 2 μm or less", as claimed, which average particle size is critical for achieving the effects of the invention.

Regarding the last point, the present specification states that "[w]hen the average particle size of the metallic powder exceeds 2 μm, the metallic powder encounters difficulty in entering the recess between the through-hole wall and the end surface of the internal electrode layer, and thus electrical connection between the via electrode and the end surface of the internal electrode is impaired." (see page 6, first full paragraph). Thus, one of ordinary skill would not expect the electrically conductive paste to connect and make contact with the receded internal electrode layer without also meeting the claimed average particle size of 2μm or less.

Mosley does not teach any particular size limitation for the average particle size of the metallic slurry used to fill the via holes.

Tani surely discloses an electroconductive paste comprising spherical or granular electroconductive metal powder having a grain size range of between about 0.1 and 50 μm. What is missing, however, is that like Mosley, Tani does not recognize the problem of the "electrode receding phenomenon" identified by Applicants, nor does Tani teach any particular size limitation for the *average particle size* of the metallic powder. More importantly, if one were to select a grain size of 25 μm midway between the grain size range taught by Tani, the problem of the receding electrode would remain - even if charged under pressure. Certainly, there is no expectation that the proposed combination would be successful, because of the wide range of 0.1 to 50 μm disclosed by the prior art with no indication of what size might be critical and with no direction as to what size to select. Certainly, the method of the present invention which requires charging under application of sufficient pressure such that the filler reaches, an end portion of the receded internal electrode layers, is not taught or suggested by the prior art. Moreover, the prior art in any event does not teach criticality of the metallic powder having an average particle size of 2 μm or less as claimed for achieving the effects of the invention.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejections under 35 U.S.C. § 103(a).

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

John K. Shin
Registration No. 48,409

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE
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CUSTOMER NUMBER

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